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Notes on a proposed New Base for the Cambrian Rocks of Southern New Brunswick

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VI.—*Notes on a proposed New Base for the Cambrian Rocks of Southern New Brunswick.*

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Many papers relative to the age and the several divisions of the Cambrian rocks of southern New Brunswick have been printed in various scientific journals during the last forty years. As a result of more recent studies the range downward of the system has been considerably extended, as compared with the original conception of the structure and distribution of these rocks, since the classification given in the report to the Geological Survey of Canada, 1870-1, by Drs. L. W. Bailey and G. F. Matthew.

To the latter much of the credit belongs for working out many details regarding the general distribution of these sediments, and for deciphering the abundant fauna which they contain, both in New Brunswick and Nova Scotia, by means of which the whole series has been divided into several distinct divisions. Within the last few years, owing to the investigations of Dr. C. D. Walcott, the recent Director of the United States Geological Survey, both in the rocks about St. John city and in similar formations of eastern Nova Scotia and in Newfoundland, a number of new features have been brought to light which have tended to simplify the general structure of the Cambrian system as a whole, and have greatly modified the views formerly held, by including in the Cambrian proper a considerable portion of the underlying formations once regarded as the Coldbrook division of the Huronian system.

It is not proposed in this paper to review in detail the various changes of opinion which have been held from time to time as to the classification of the rocks of this system; but rather to direct attention to certain points of structure, and to the occurrence of certain organisms found at different localities, which hitherto do not appear to have received the consideration which they deserve; in order, if possible, to render the structure of the Cambrian rocks proper, and their relations to those which have been, for a long time, regarded as occupying a much lower horizon, more intelligible. Recent study of the areas about St. John city have shewn that these lower rocks are closely related to and may form, possibly, an integral portion of the Cambrian system regarded as a whole.

In the earlier classification of the rocks about St. John city, 1870-1, they were arranged under three heads or groups comprising the Laurentian, the Huronian and the Cambrian systems. Of these the Laurentian was regarded as divisible into a lower and an upper portion which were supposed to be the equivalents of the Laurentian of the Province of Quebec, the lower division representing the Fundamental gneiss of that province, while the upper was regarded as similar in age to the Grenville series. The former comprises granites, sometimes having a gneissic structure, gabbros, diorites, etc.; the latter consists largely of crystalline limestone associated with slates, schists and sandstone or quartzite, with which were also included masses of igneous rocks.

The second great group, known as Huronian, was divided into three parts, the Coastal, Kingston and Coldbrook, having an aggregate thickness of many thousand feet. Large portions are of igneous origin, and the upper part of the Coldbrook was supposed possibly to form transition beds into the base of the Cambrian. Both of these series or systems were so established from the fact that in part at least they were regarded as underlying the fossiliferous Cambrian system proper, or as then understood, and in consequence they were frequently known under the general term Pre-Cambrian. The upper part of the Coldbrook comprised a considerable thickness of reddish and purple, sometimes grayish sediments, with certain areas of igneous felsitic rocks, all of which were held to underlie unconformably the gray and dark slates and quartzite of the St. John group or primordial Silurian as developed about the city of St. John.

The study of this lower portion was next taken up by Drs. Matthew and Walcott, and collections of fossils were made, which shewed that these hitherto somewhat doubtful rocks, which were styled Etcheminian, might constitute the lowest fossiliferous zone of the Cambrian system. They were in consequence removed from the Coldbrook Huronian. A partly igneous series at the base of the recognized Etcheminian was also included in the Cambrian terrane under the name "Coldbrookian." The series as a whole is composed of slates, quartzite, limestone and thin conglomerates and was arranged under four heads known in ascending order above the Coldbrookian, as Etcheminian, Acadian, Johannian and Bretonian, the last passing upward into the lower Ordovician, with a fauna of graptolites, etc., similar to forms found in the Lévis division of the Quebec group, as developed at and near Point Lévis, opposite the city of Quebec. Throughout all these Cambrian divisions about St. John there is an apparent conformity, except where the arrangement of the several divisions is broken by well-defined lines of faulting.

The position of the Cambrian on the underlying rocks was found to vary considerably at different points. Thus to the east of St. John the lowest portion rests on the Coastal division of the Huronian, but occasionally overlies the Kingston and Coldbrook, while in the west part of St. John city, as at the suspension bridge, the upper or Bretonian division of the Cambrian is in contact with the limestone, quartzite and slates which have been regarded as belonging to the upper Laurentian series. This is the series which is at present of special interest from the geological standpoint; and the contact of the Bretonian is marked by a fault which extends from the end of the suspension bridge eastward along what is known as the strait shore.

This age of the upper Laurentian division was assumed by Drs. Bailey and Matthew, and supported in part by Sir William Dawson, partly on lithological grounds and partly from finding in portions of the limestone certain peculiar forms supposed to be organic in character, and to be related to the form known as Eozoon, which occurs in the Grenville series of Quebec and the Hastings series of Ontario. In southern New Brunswick it received the name, given by Matthew, of Archæozoon. The history of this supposed Laurentian organism is somewhat interesting, and as it has a somewhat important bearing on the original interpretation of the structure of the St. John rocks may be here briefly stated.

The peculiar form known as Eozoon was first found in Quebec nearly fifty years ago, associated with the upper Laurentian formation north of the Ottawa river, and shortly after somewhat similar forms were recognized in eastern Ontario. It was chiefly studied by the late Sir William Dawson, and was supposed to represent the earliest known form of life. In the course of investigation on these old rocks of Ontario and Quebec, where this form was principally recognized, it was ascertained that as regards the Ontario specimens, the organic nature of the supposed fossil could not be maintained, since the specimens known as the Tudor and Burgess Eozoon were closely and clearly associated with igneous rocks which occurred as dikes cutting the crystalline limestone, and the supposed organism owed its peculiar structure to forms developed in the intrusive portions, which were diabasic in character, rather than to occurrences in the limestone itself.

In course of time, therefore, the contention as to the organic nature of these forms from Ontario was gradually abandoned, but the organic nature of the Quebec specimens was still maintained, chiefly by Sir William Dawson. The best specimens of Eozoon were found principally in a quarry at Côte St. Pierre, about forty miles east of Ottawa. A subsequent critical examination of this locality clearly shewed that in this case also, the Eozoon structure was due to the association with igneous rocks, principally a gabbro diorite, with limestone. The quarry was originally opened in a serpentinized zone of the limestone near the contact with the gabbro mass, for the extraction of asbestos (crysotile), a mineral occurring at a number of places in the crystalline limestone of eastern Quebec as small threads or veinlets.

This serpentinized portion when present always occurs at or near the base of the calcareous bands, and often is accompanied with a development of the crysotile. Attempts to mine this mineral have been frequently made near the igneous contacts, and it was evident, on careful study of the conditions at a number of these openings, that the alteration to serpentine and the development of the crysotile veins was due to the action of the intrusive masses on the basal portion of the limestone bands. The original contention therefore that these forms known as Eozoon were of organic origin has practically ceased to exist or to find supporters.

As regards the peculiar forms found in the crystalline limestone in the vicinity of St. John, which have been described under the name Archæozoon, from several localities, the same intimate association of igneous masses is frequently observed. In the report to the Geological Survey, 1870-1, by Bailey and Matthew, they are referred to as occurring in beds of limestone exposing "over a surface nearly ten feet square, large numbers of concentric nodular masses, bearing much resemblance to some genera of corals, but apparently destitute of organic structure, and probably concretionary." From their presence, however, in limestone in which sponge spicules are found, they may possibly belong to one of the lower orders of sponges, related to the Archæocyathus of Newfoundland. They certainly bear but small resemblance, either in mode of occurrence or general aspect, to the form known as Eozoon Canadense of Ontario or Quebec. A description of this form was published by Dr. Matthew in Bull. No. IX, Nat. Hist. Soc., N.B., 1890, in which its organic nature is maintained.

In the same bulletin Dr. Matthew also pointed out that in the so called upper Laurentian of southern New Brunswick, as found about St. John, three zones were recognizable which contain fossil forms. These were held to be separated from the then recognized base of the Cambrian by the Huronian series. His statement as to the occurrence of these fossils in these upper Laurentian rocks, as there given, may be briefly summarized, in order to arrive, if possible, at a clearer understanding of the problem of their structure, which is now a matter of considerable geological importance.

As already intimated, the rock formations of this series consist of crystalline limestone, slate and quartzite, with masses of intrusive rocks. The sediments contain organic remains, of which the oldest apparently is in the quartzite portion belonging to the lower part of this division of the system, and consist of the remains of hexactonellid sponges probably allied to the genus Cyathospongia. The second series of organisms is in the upper limestone division of this series, the fossils here found being of a different nature from the ordinary sponge spicules in having a calcareous coral-like structure, somewhat resembling certain forms found in the basal portion of the Cambrian elsewhere. The structure of this organism has not yet been definitely worked out, but it consists of elongated cylindrical objects with bodies from one to three inches across and several inches in length. This is the object described as Archæozoon Acadicum.

The third zone is that of the graphite beds or graphitic slates in which occur great numbers of sponge spicules, arranged in parallel sets, one set crossing another at an acute angle. This type of sponge is apparently Monactinellid. As only straight needle-like spicules without rays have been obtained of this sponge it probably was a mass of sarcode or jelly, protected and sustained by the spicules which traversed it.

In a second paper in the same bulletin, 1890, Dr. Matthew more definitely describes the occurrence of these sponges in the upper Laurentian rocks of this district. Here in beds of quartzite associated with the limestone of Drury Cove several miles north-east of St. John, also regarded as of upper Laurentian age, both solitary spicules and fragments of the net-work of a sponge, apparently of the genus Cyathospongia eozoica occur, resembling fragments of Hexactinellid sponges found in the lower beds of the Etcheminian division of the true Cambrian of that area. These forms were also obtained from smooth graphitized layers in the limestone itself as also in large numbers from the graphitic slates associated with the crystalline limestone near the suspension bridge across the St. John river, at the west end of Douglas avenue. These are referred to Sir William Dawson's provisional genus Halochondrites. The horizon of these beds is stated to be the lower half of the upper division of the upper Laurentian. These forms occur in other localities where the containing rocks are highly graphitized. Above these beds, in the original scheme of classification are placed the Huronian system with an estimated thickness of more than 25,000 feet to the base of the Cambrian as usually understood.

In considering the horizon of the slates, quartzite and crystalline limestone about St. John just described, it will be seen that any evidence derivable from a comparison of these fossils with the supposed organisms from the Grenville and Hastings series, may be practically disregarded. According to the latest examination of these rocks in Quebec and Ontario, they appear to be referable to the Huronian rather than to the Laurentian proper, and neither of these series has yielded any fossil evidence whatever of determinative value.

The age of much of the granite and other igneous rocks which, in the classification of 1870-1, were assigned to the lower Laurentian, is also largely problematical; and the same remarks will apply to large portions of the original Huronian, which in the published map of southern New Brunswick were described under the head of Pre-Cambrian. These views were later modified as a result of recent examinations in Charlotte country. For while without doubt there are areas of these rocks which are fairly entitled to be classed as Pre-Cambrian, other large portions, both of the igneous and stratified rocks about St. John and westward, once regarded as Laurentian or Huronian, have been found to be newer intrusives which alter sediments containing Silurian fossils, or to be still newer sediments, in part of Devonian age, which have been changed into schists and crystalline limestone, in which the remains of organisms can be readily observed. As for the supposed Laurentian rocks about St. Stephen in Charlotte county, on which much of the geological classification of this part of the province was based, it must be said that they present but small evidence, either in their physical character or their stratigraphical relations, to entitle them to such a position.

On the other hand, the general aspect of the crystalline limestone, associated slate and quartzite of the series resembles closely the recognized Cambrian rocks of the district but in a higher state of metamorphism. Such alteration has been largely local in character, and the causes can be readily seen in the presence of large masses of igneous intrusive rocks, the metamorphism being more marked as these igneous rocks are approached. Much of the alteration is also doubtless due to the large amount of folding which has affected great portions of the several formations. In the case of the limestone such alteration is evident in the fact that otherwise bluish slaty beds are changed to the white crystalline character, while the granite and diorite often cut across the limestone and slate and sometimes carry pieces of the adjacent rock in the igneous mass.

The limestone developments are often quite local, occurring frequently as small narrow lenses surrounded by slate or quartzite, while in other places they spread out into areas of considerable extent, though in such cases the limestone is broken up and largely reduced by the granite. In the occurrence of these limestone bands they closely resemble portions of the lower Sillery formation of eastern Quebec.

The presence of sponge spicules in these rocks is also interesting. Similar forms are very abundant in the lower and middle Sillery

(Cambrian) as at Métis and elsewhere, from which Hexactinellid sponges were obtained some years ago, and described by Sir William Dawson in a paper read before this Society in 1889. Some of these forms from the Cambrian of Quebec appear to be almost identical in character with those from the beds about St. John; but nowhere in Canada or elsewhere, in so far as known have they been obtained from rocks of lower horizons than the basal Cambrian;. the species known as Archæocyathus, found in Newfoundland many years ago, and doubtfully referred to the upper Huronian or lower Cambrian being the oldest known form yet recorded. The exact nature of this organism, whether a coral or a sponge, is still somewhat uncertain. It is generally regarded, however, as representing the lowest known representative of the sponges.

To separate these low forms found in the St. John rocks from other low types of sponges obtained from the Etcheminian division of that city by some 20,000 feet or more of Huronian rocks is a problem requiring careful consideration ; since if the former determinations of horizons are to be taken as correct, it would imply an enormous interval of time with but little change in the character of the organisms which occur in the middle and lower Cambrian and those from the so-called upper Laurentian of this area.

Summing up the present evidence bearing on the question, it would seem that the portion of these St. John rocks, formerly assigned to the horizon of the upper Laurentian, is more closely related to the recognized middle and lower Cambrian, both as regards their physical character, their stratigraphical sequence and their contained fossils, than to any other series of formations found in the area about that city. It may be mentioned in this connection that in the list of organisms published by Dr. Matthew as occurring in the Etcheminian portion of the Cambrian (Bull. Nat. Hist. Soc. Vol. X) a number of forms are given, including several varieties of Archæocyathus such as pavenoides, elegans, elongata, virguloides, all of which are referred to Div. C. of the St. John group with remains of Protospongia; while several forms including Dichoplectella, Hyalostelia, and Plotoscyphia, are referred to the horizon of the Etcheminian or lowest division of the Cambrian. The forms Cyathospongia and Halichondrites, found in the supposed upper Laurentian of St. John, are given in Sir William Dawson's list as occurring in the Sillery division of the Quebec group (Cambrian) at Metis.

Another point of considerable interest in connection with the lowest hitherto recognized beds of the Cambrian of southern New Brunswick, is the apparent absence in all the sections made in the several areas about St. John city and eastward to Handford brook, of the genus Olenellus, regarded as marking the basal member of the Cambrian, but which up to the present time has not been found in Nova Scotia or New Brunswick though it occurs in the basal beds of the Etcheminian of Newfoundland and in their supposed equivalent the Georgia series of Vermont.

In the lowest portion of the Cambrian section as developed along Handford brook, the species Colonoides which is found associated with Olenellus elsewhere, was obtained from the Etcheminian of that section. In the vicinity of St. John the recognized Etcheminian in rear of Seely street, as measured by Walcott, has a thickness of only 150 feet, as contrasted with 1040 feet developed on Handford brook. In the former area however, a belt of greenish eruptive felsitic and sometimes slaty rocks underlies the sediments of the fossiliferous Etcheminian and extends from the vicinity of Main street in the city, past Lily lake and eastward for some miles. This is terminated downward by beds of dark slates, altered sandstone and bands of crystalline limestones, sometimes graphitic, and is evidently a portion of the formation which contains remains of sponges already described. This part of the series presumably is included in the Cambrian term Coldbrookian.

Their extreme metamorphism is evidently due to the presence of large masses of generally reddish granite, and it is quite possible that they may represent in this direction the missing basal beds of the Etcheminian as developed elsewhere. It is also possible that a careful search might reveal the existence of the missing Olenellus zone with its associated fossils. So far in the study of this part of the field, but little attention has been directed to this aspect of the case, either at this locality or elsewhere, possibly on the assumption that their supposed upper Laurentian age was against the probability of finding any such organisms; but the abundance of sponge spicules in these lower rocks, as already indicated, now makes it very desirable that a close search be made in order that this missing lowest fossiliferous zone of the Cambrian system in this portion of the province may be discovered ; unless indeed the high state of metamorphism to which these rocks have been subjected may have entirely destroyed all trace of any such organisms.